International Centre for Free and Open Source Software

Integrating ULPLoRa Board with DHT11 Sensor for Temperature and Humidity Monitoring and Visualization.

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Contents

1 INTRODUCTION

This documentation presents a comprehensive guide for integrating the ULPLoRa board with the DHT11 sensor for temperature and humidity monitoring and visualization in IoT applications. The ULPLoRa board combines an Arduino Pro Mini with an RFM95W LoRa module, providing a flexible platform for wireless communication, while the DHT11 sensor offers accurate temperature and humidity measurements.

The primary objective of this document is to outline a systematic approach to establishing a robust system capable of capturing temperature and humidity data, wirelessly transmitting it via LoRa to the ChirpStack server, storing it in InfluxDB, and subsequently visualizing it using Grafana.

The documentation provides detailed guidance on hardware setup, firmware development, ChirpStack configuration, InfluxDB integration, and Grafana visualization tailored for the DHT11 sensor.

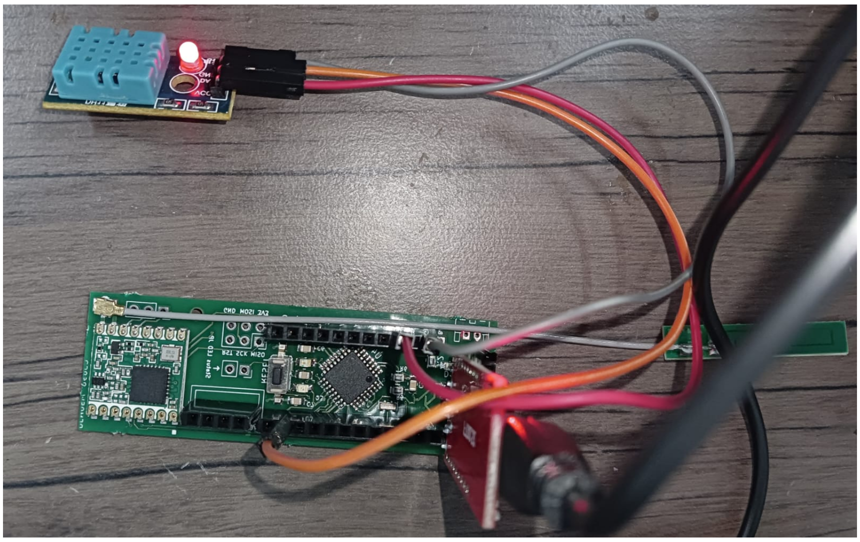

Figure 1

2 COMPONENTS USED

2.1 Hardware Components:

2.1.1 ULPLoRa Board:

- The ULPLoRa board integrates an Arduino Pro Mini with an RFM95W LoRa module, enabling wireless communication for IoT applications.
- Number of Pins: 14 digital pins and 8 analog pins.
- Working Voltage: 3.3V
- Microcontroller: ATmega328P
- Clock Speed: 8MHz.
- Explore the ICFOSS gitlab repository to access comprehensive documentation, including schematics, pinouts, and setup instructions for the ULPLoRa board. (https://gitlab.com/icfoss/OpenIoT/ulplora)

2.1.2 DHT11 Sensor:

- Number of Pins: 3 (VCC, GND, DATA).
- Working Voltage: 3V to 5.5V (typically powered by 5V).
- Working: The DHT11 sensor measures temperature and humidity. It communicates with the Arduino Pro Mini via a single data line (DATA) to provide temperature and humidity data for monitoring purposes.

2.1.3 FTDI FT232RL USB to Serial Adapter:

- The FTDI FT232RL USB to Serial Adapter is used for serial communication between the ULPLoRa board and a computer. It facilitates programming and debugging tasks.
- Number of Pins: 6 (typically: TXD, RXD, DTR, 5V, GND, CTS).
- Working Voltage: 5V.

2.2 Software Components:

2.2.1 Libraries Used:

- **MCCI LoRaWAN LMIC Library:**
  - The MCCI LoRaWAN LMIC library is utilized to interface with the ULPLoRa board's RFM95W LoRa module and implement LoRaWAN communication.
  - This library simplifies LoRaWAN development by providing functions for sending and receiving LoRaWAN messages and managing LoRaWAN parameters.

  - To access this library, clone the ULPLoRa repository from the ICFOSS GitLab repository and navigate to the software folder:
    https://gitlab.com/icfoss/OpenIoT/ulplora

- **DHT11 Library:**
  - The DHT11 library is used to interface with the DHT11 sensor for temperature and humidity measurements.
  - Install this library using the Arduino IDE's Library Manager by searching for "DHT sensor library" and following the installation instructions.
  - Alternatively, you can download the library from GitHub at :
    https://github.com/dhrubasaha08/DHT11

2.2.2 ChirpStack Server:

ChirpStack serves as an open-source LoRaWAN Network Server, facilitating communication between LoRa devices and applications. It acts as the central hub for receiving and processing data from the ULPLoRa board.

2.2.3 InfluxDB:

InfluxDB is an open-source time series database optimized for handling high write and query loads. It is utilized to store the Temperature and Humidity data received from the ULPLoRa board via ChirpStack.

2.2.4 Grafana:

Grafana is an open-source analytics and visualization platform designed for creating and sharing dashboards and data visualizations. It enables the visualization of the Temperature and Humidity data stored in InfluxDB, providing insights into atmospheric Temperature and Humidity trends over time.

3 HARDWARE CONNECTIONS SETUP

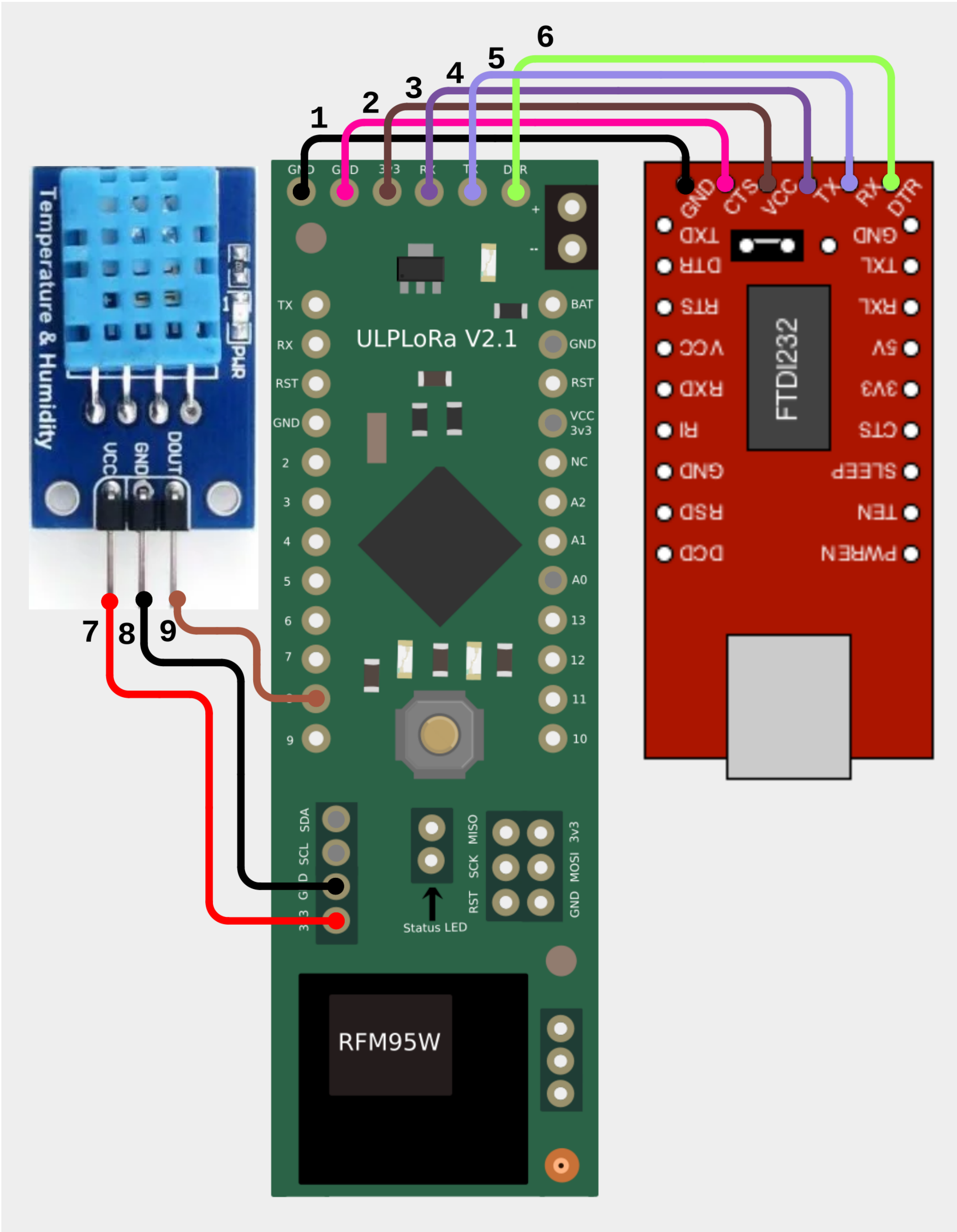

Figure 2: Hardware Connections Setup Circuit Diagram

3.1 ULPLoRa Board (Arduino Pro Mini 3.3V 8MHz) and FTDI FT232RL USB to Serial Adapter:

1. Connect the GND pin of the FTDI adapter to the GND pin of the ULPLoRa board.
2. Connect the CTS pin of the FTDI adapter to the GND pin of the ULPLoRa board.
3. Connect the 5V pin of the FTDI adapter to the VCC pin of the ULPLoRa board.
4. Connect the RX pin of the ULPLoRa board to the TX pin of the FTDI adapter.

5. Connect the TX pin of the ULPLoRa board to the RX pin of the FTDI adapter.
6. Connect the DTR pin of the FTDI adapter to the DTR pin of the ULPLoRa board.

3.2 ULPLoRa Board and DHT11 Sensor:

7. Connect the VCC pin of the DHT11 sensor to the 3.3V output pin of the ULPLoRa board.
8. Connect the GND pin of the DHT11 sensor to the GND pin of the ULPLoRa board.
9. Connect the DHT11 sensor to digital pin 8 on the ULPLoRa board for data communication.

4 CONFIGURING CHIRPSTACK, INFLUXDB, AND GRAFANA

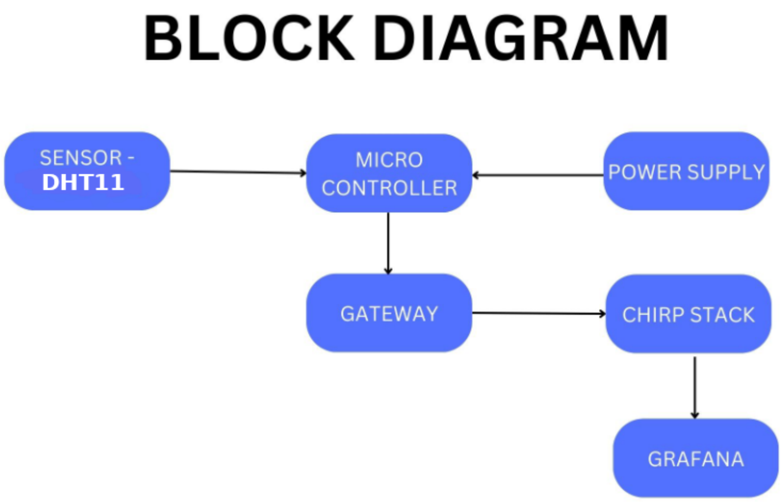

Figure 3: Block diagram

4.1 ChirpStack Configuration:

1. Log in to the ChirpStack web interface (https://lorawandev.icfoss.org).

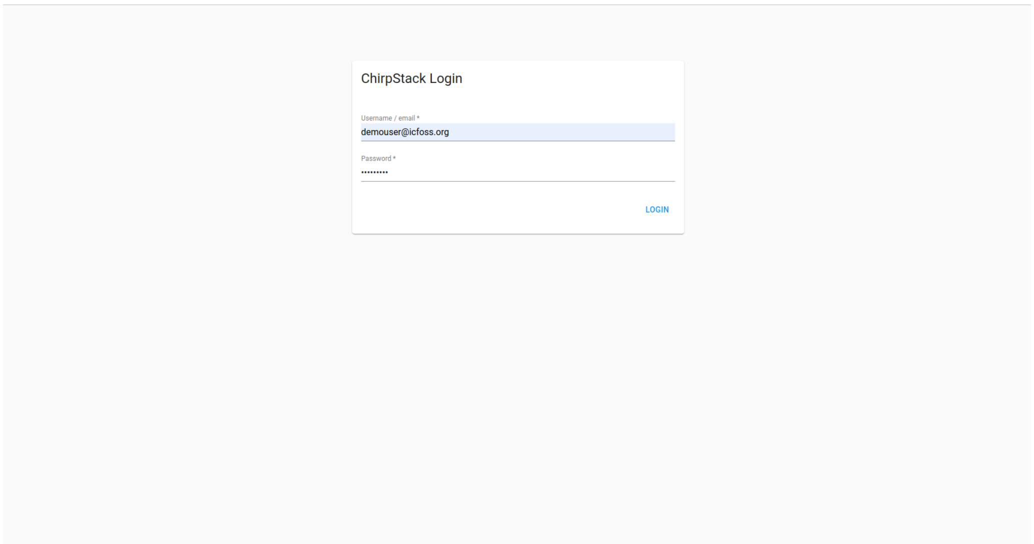

Figure 3.1: Login

2. Navigate to the "Device Profile" section

3. Click on "Create Device Profile" and provide necessary details such as name, description, and LoRaWAN parameters.

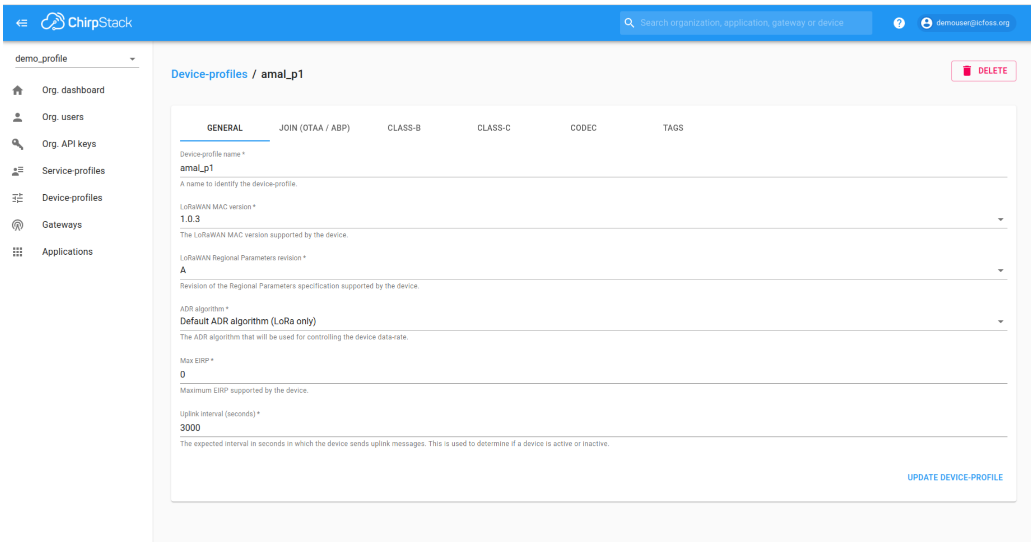

Figure 4: Device profile creation

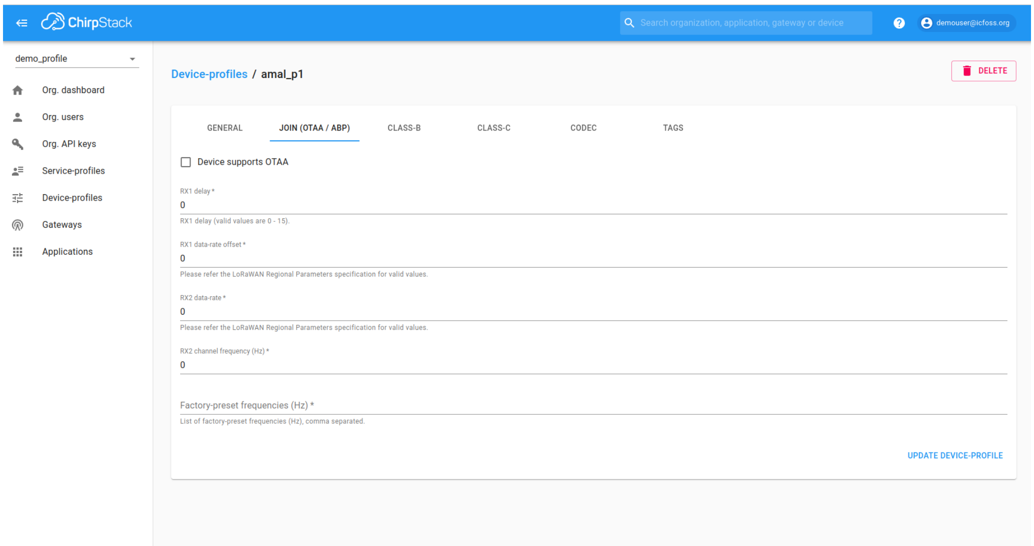

Figure 5: Device profile creation

4. Save the device profile.
5. After creating the device profile, navigate to the "Applications" section.
6. Click on "Create Application" and enter the required information such as name and description.

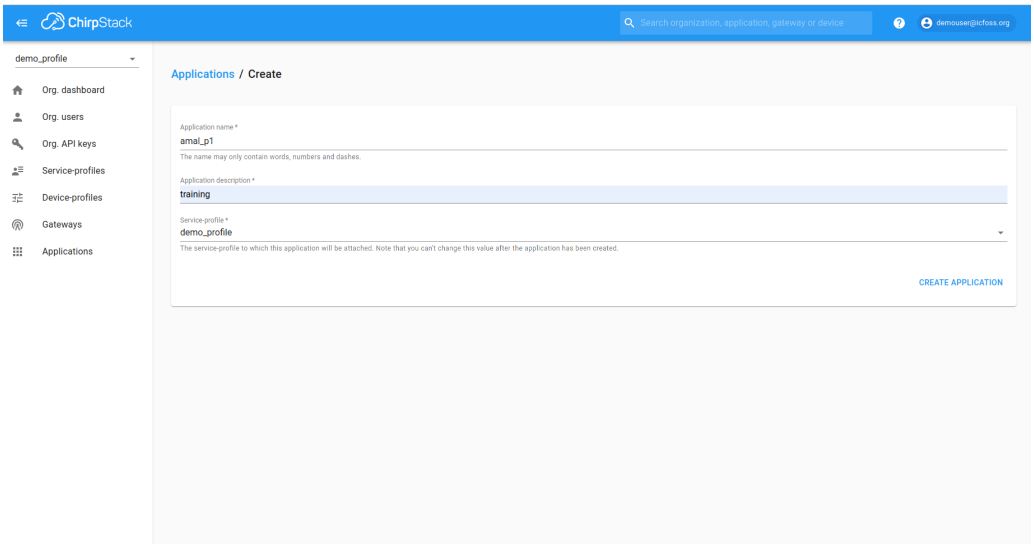

Figure 6: Creating new application

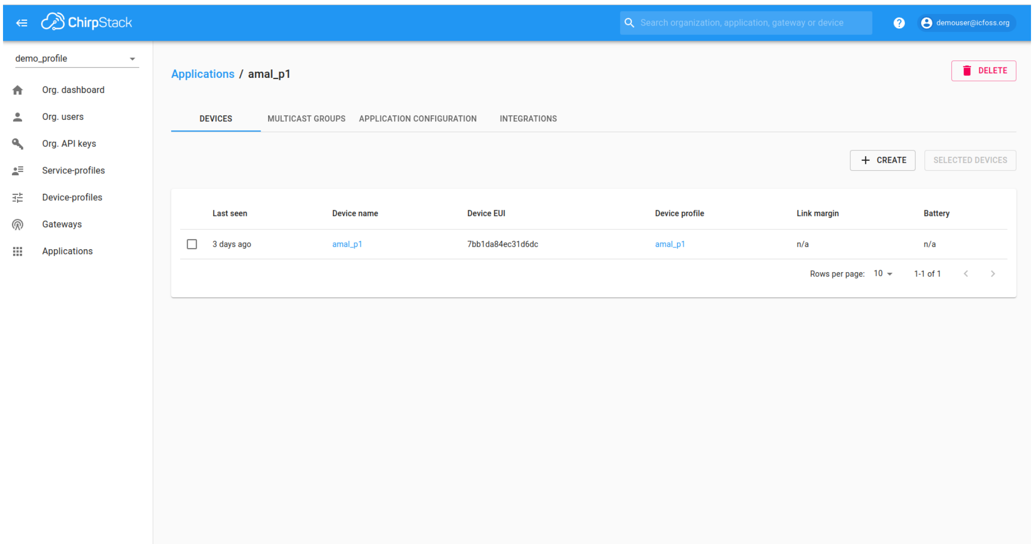

Figure 7: Creating new application

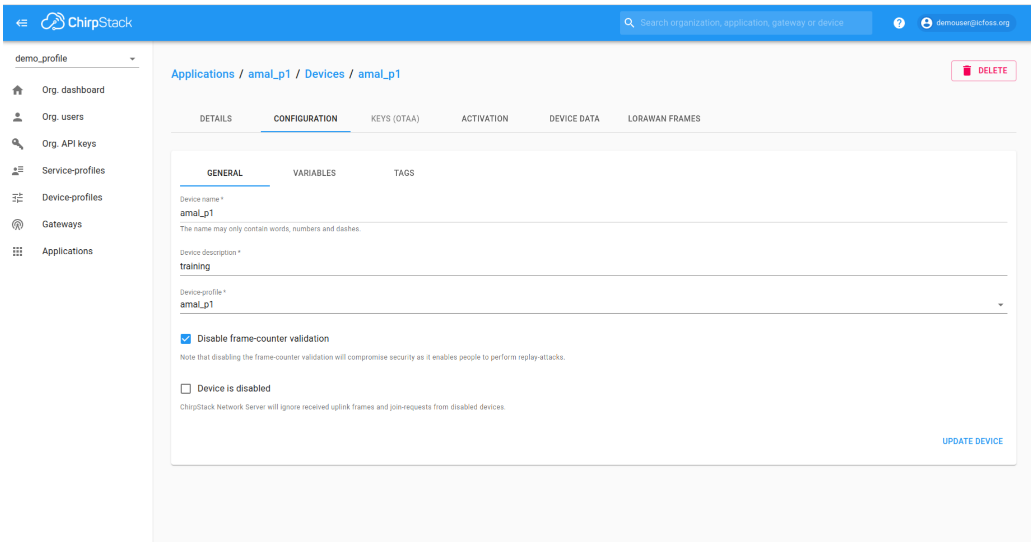

Figure 8: Creating new application

7. Save the application configuration.

8. Obtain network session key and application session key (as hex array) from the activation tab of the created application and paste it in the code.

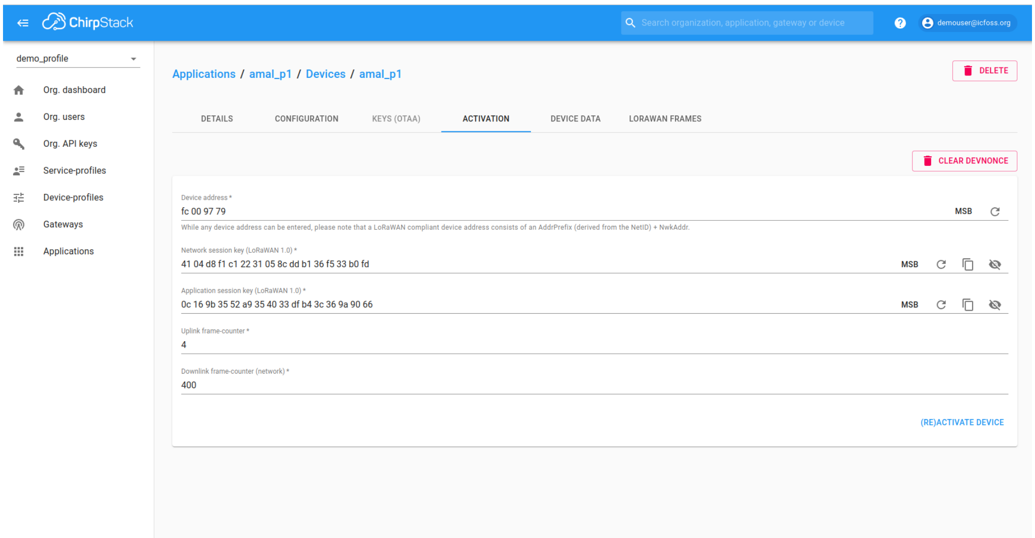

Figure 9: Obtain network session key and application session key

4.2 InfluxDB Configuration:

1. Log in to InfluxDB (http://117.223.185.200:8086/signin).

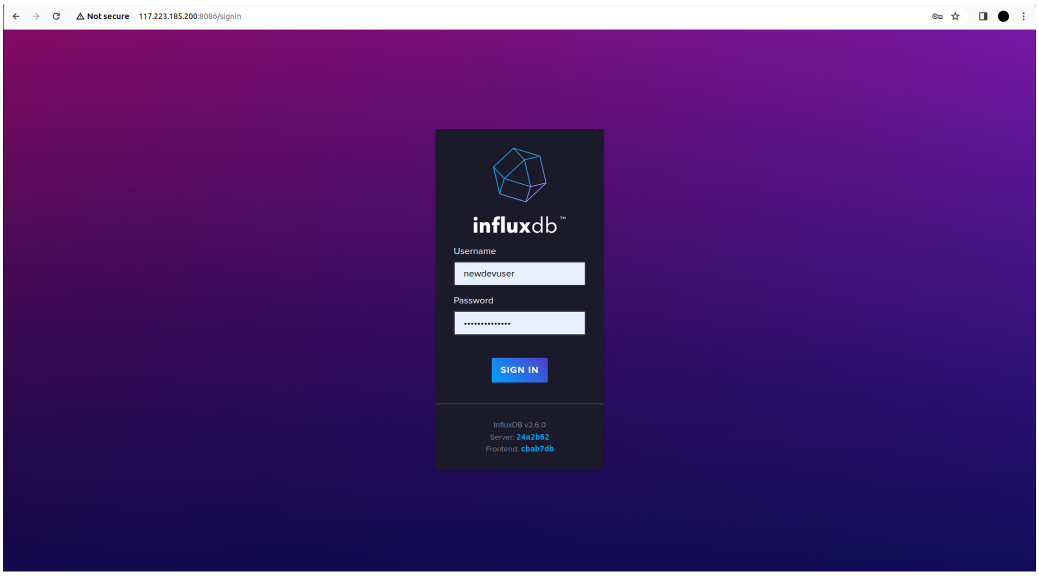

Figure 10: influxDB login

2. Create a new API token.

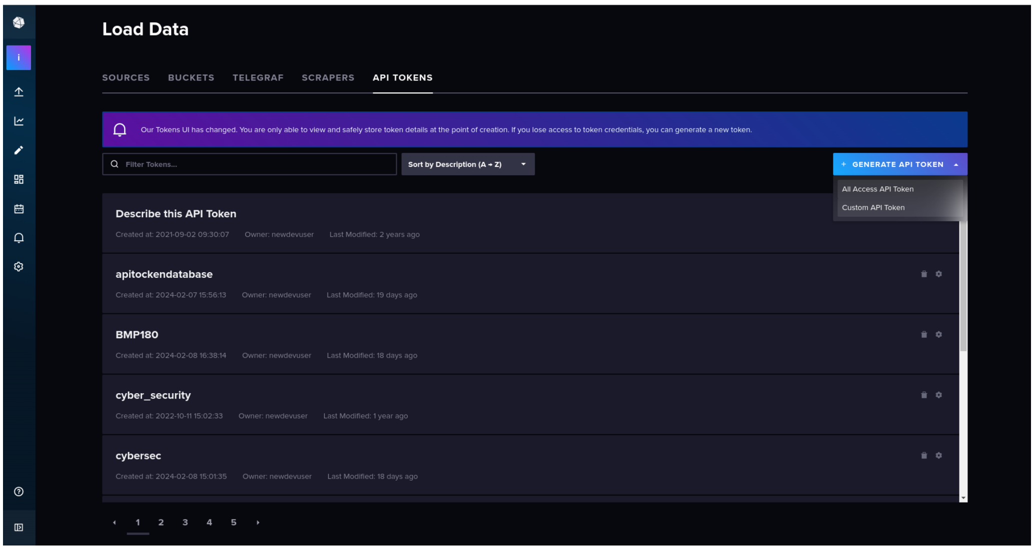

Figure 11: create API token step 1

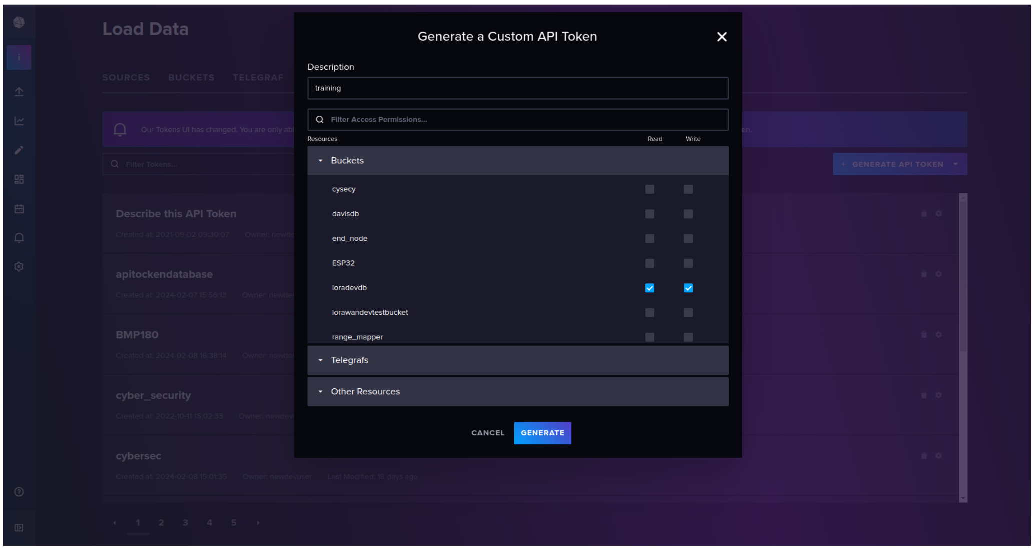

Figure 12: create API token step 2

3. Copy the generated token

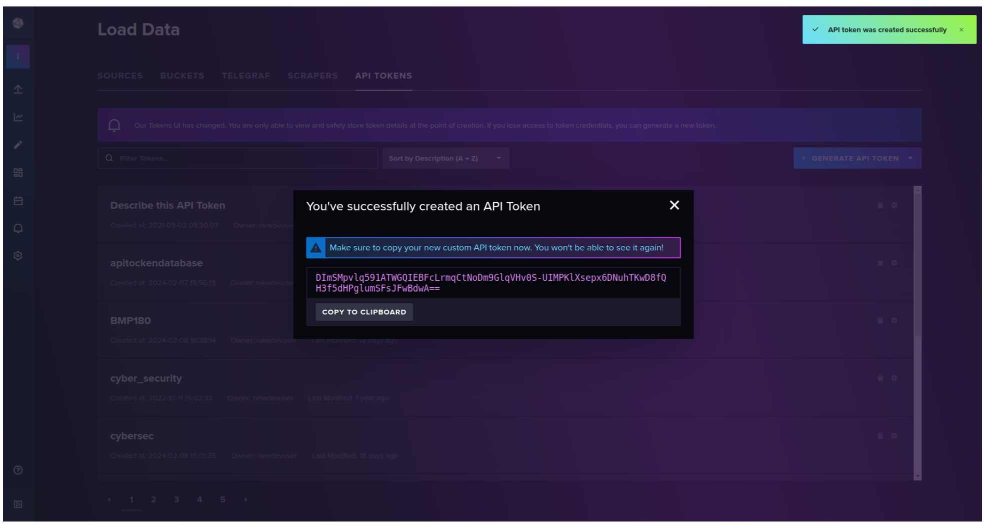

Figure 13: Token generated

4.3 Integrating ChirpStack with InfluxDB:

1. Return to ChirpStack server and navigate to the created application.
2. Select the integration tab and choose InfluxDB.
3. Enter the InfluxDB details and paste the API Token.

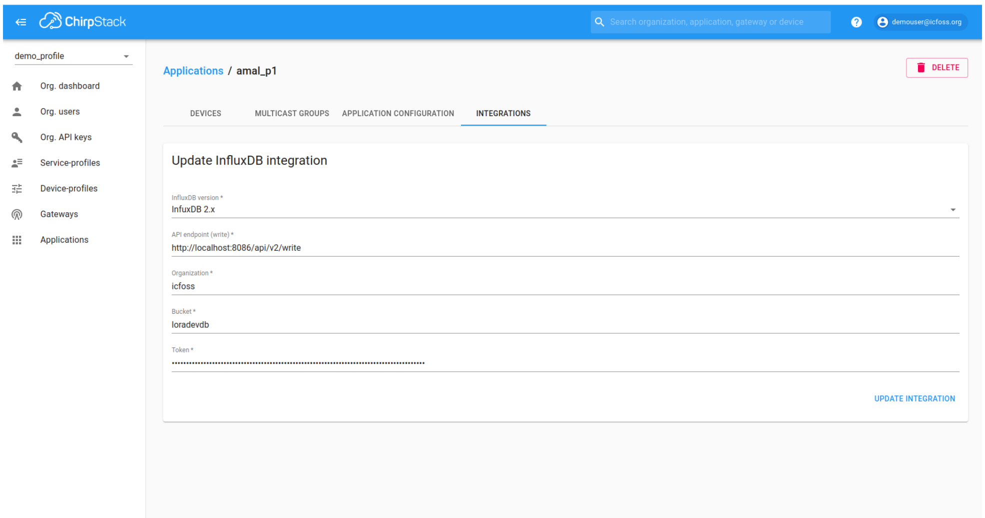

Figure 14: Integrating ChirpStack with InfluxDB

4.4 Integrating InfluxDB with Grafana:

1. Open a web browser and navigate to the InfluxDB interface (http://117.223.185.200:8086/signin
2. Log in using your credentials to access the InfluxDB dashboard.
3. Once logged in, locate and select the appropriate bucket(loradevdb).

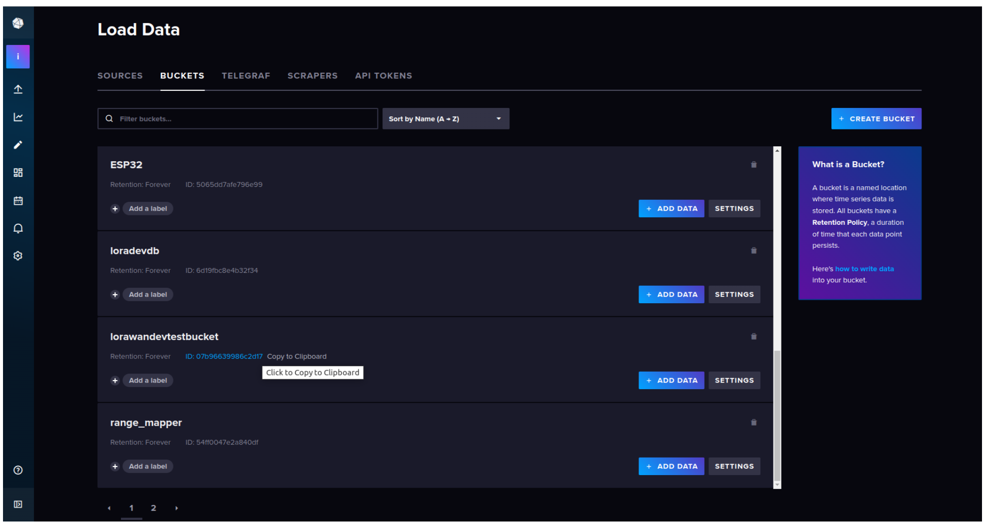

Figure 15: Select Bucket

4. Navigate to the specific data source(Temperature and Humidity Data).

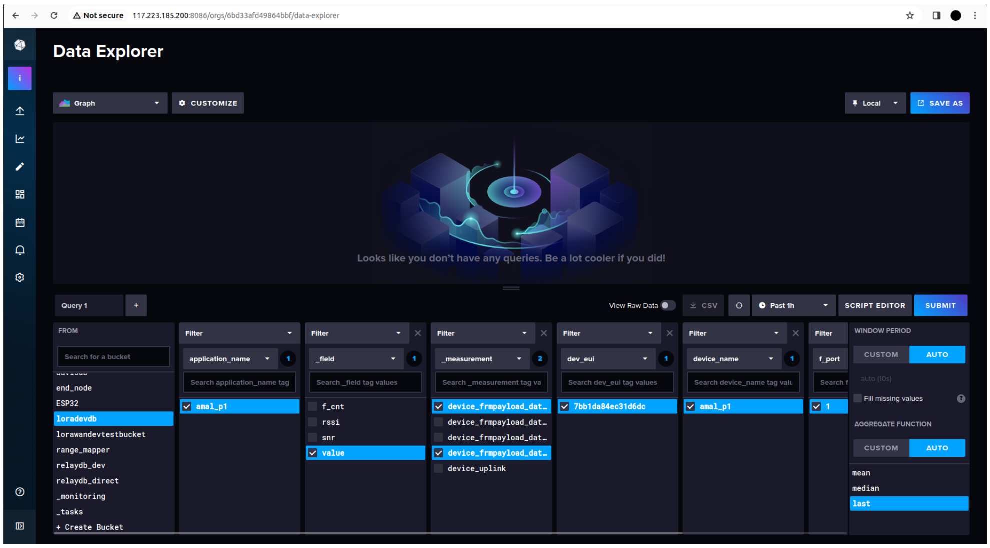

Figure 16: Data Source

5. Switch to query builder and copy the query.

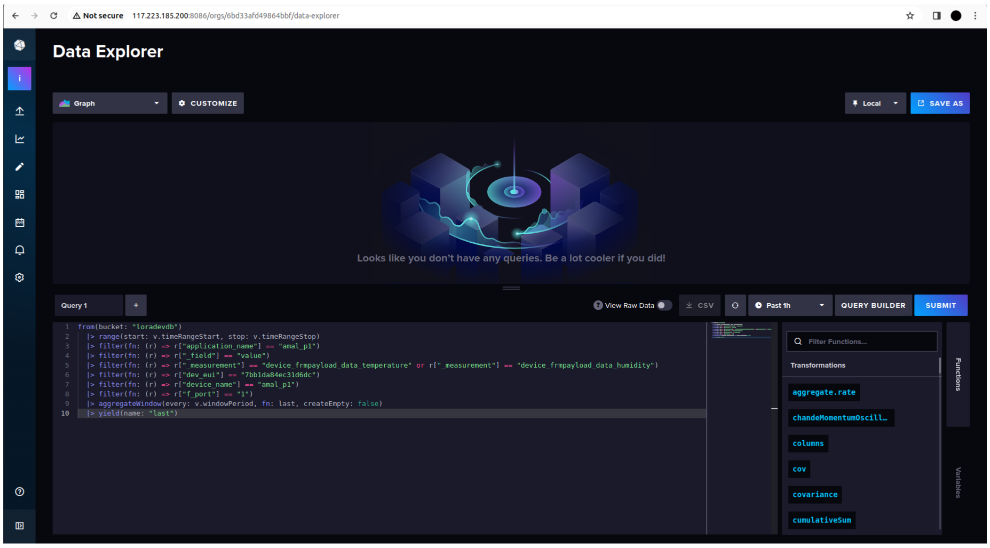

Figure 17: Query Builder

4.5 Grafana Configuration:

1. Log in to Grafana (https://visualizedev.icfoss.org/login).

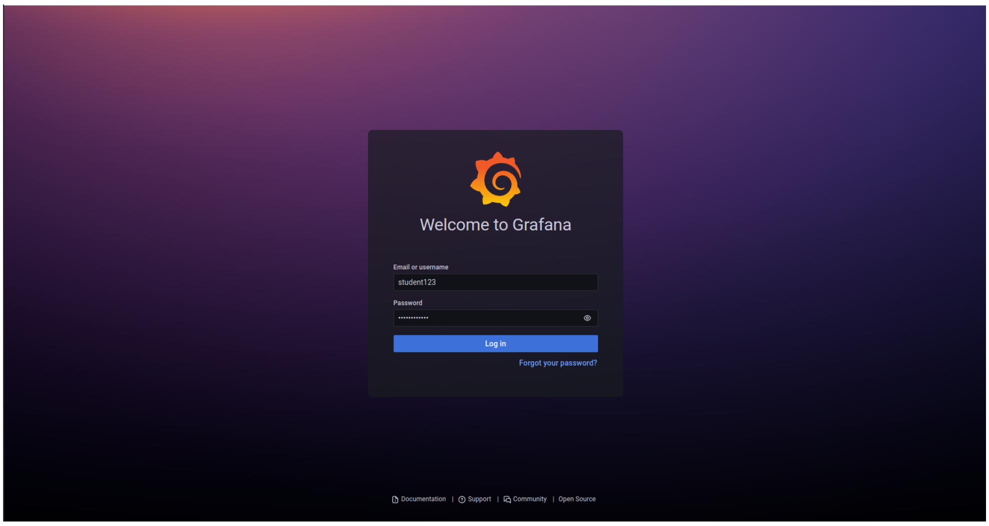

Figure 18: Grafana Login

2. Create a new Dashboard.

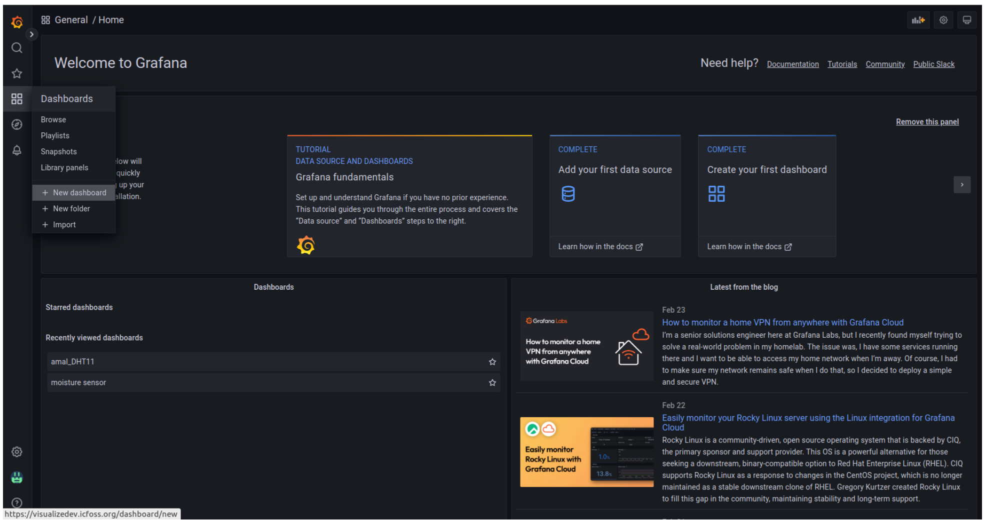

Figure 19: New Dashboard

3. Create a new panel, choose stats, and paste the copied query.

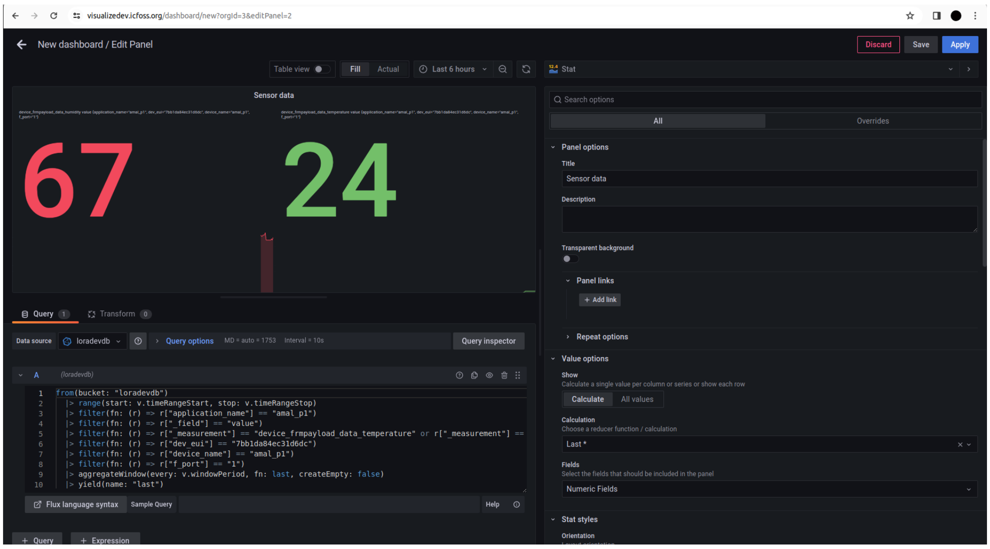

Figure 20: Panel for Temperature and Humidity

4. Add Heading and unit.

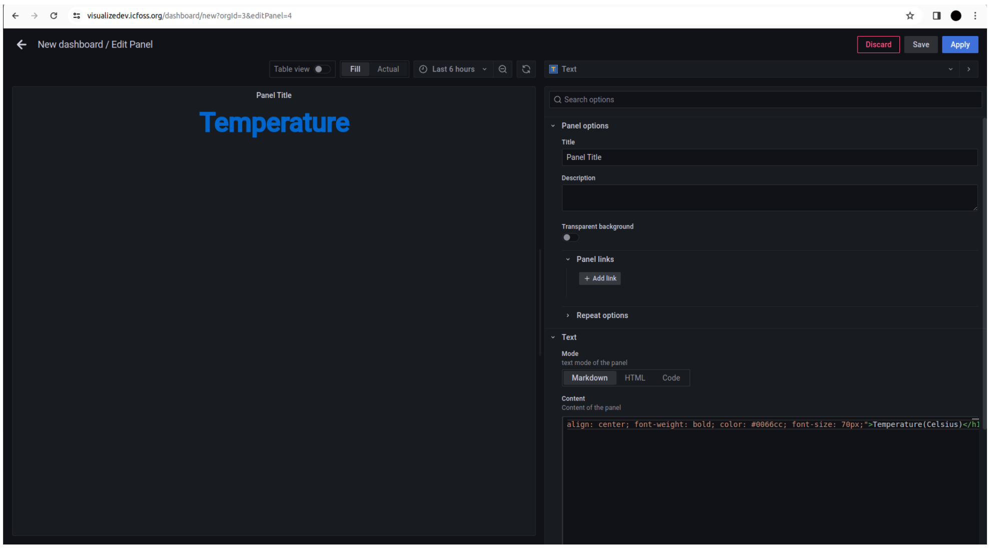

Figure 21:Heading and Unit Panel of Temperature

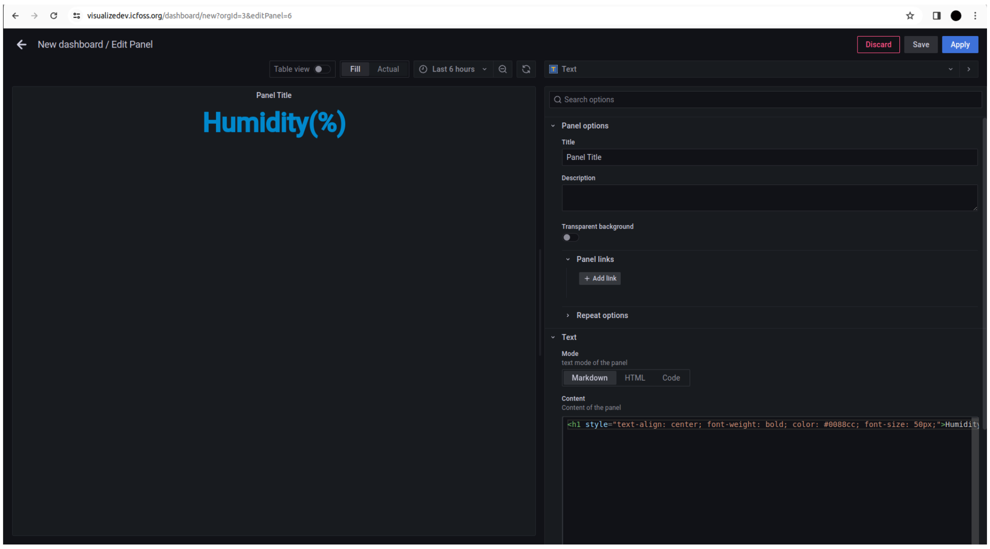

Figure 22:Heading and Unit Panel of Humidity

5. Save the Dashboard.

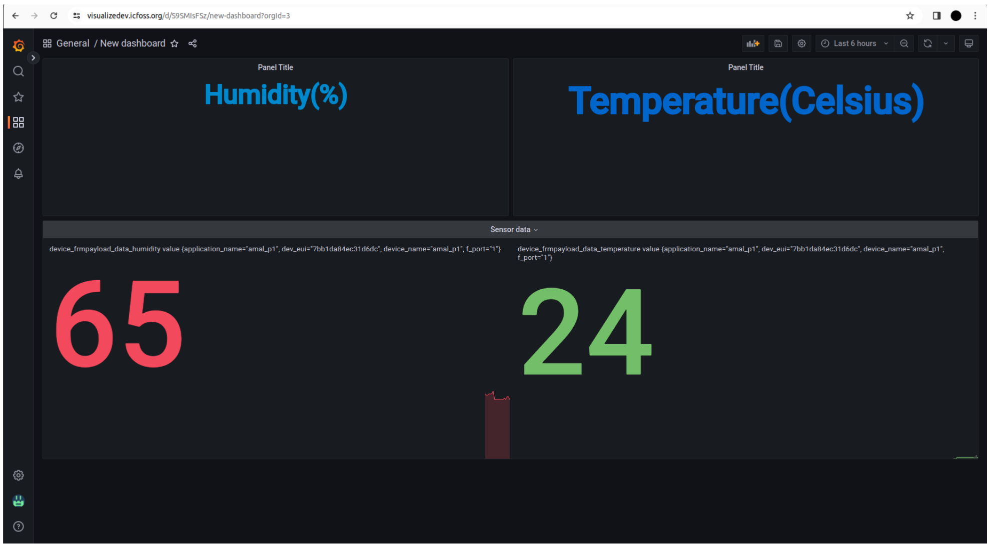

Figure 23: Final Dashboard

5 RESULT

The integration of the ULPLoRa board and DHT11 sensor, coupled with the utilization of the MCCI LoRaWAN LMIC library for LoRaWAN communication and the DHT11 library for sensor interfacing, enables seamless data capture and transmission within IoT applications. This setup facilitates accurate monitoring of temperature and humidity readings, empowering users to gather valuable environmental data efficiently. Furthermore, the integration with ChirpStack for LoRaWAN network management, InfluxDB for data storage, and Grafana for data visualization enhances the system's capability to monitor and analyze environmental metrics effectively.